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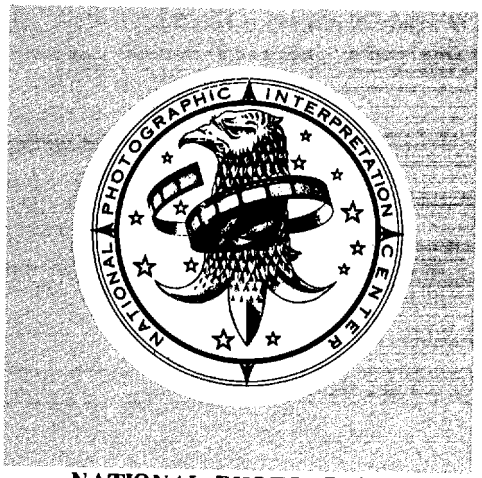

NATIONAL PHOTOGRAPHIC
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TECHNICAL PUBLICATION

TEST AND EVALUATION REPORT

P. I. STAGE RETICLES

NPIC/R-09/74
FEBRUARY 1974

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Comments and queries regarding this report are welcome.
They may be directed to [redacted] STATINTL
NPIC/TSG/ESD/TEB, Code 143, Ext. 3681

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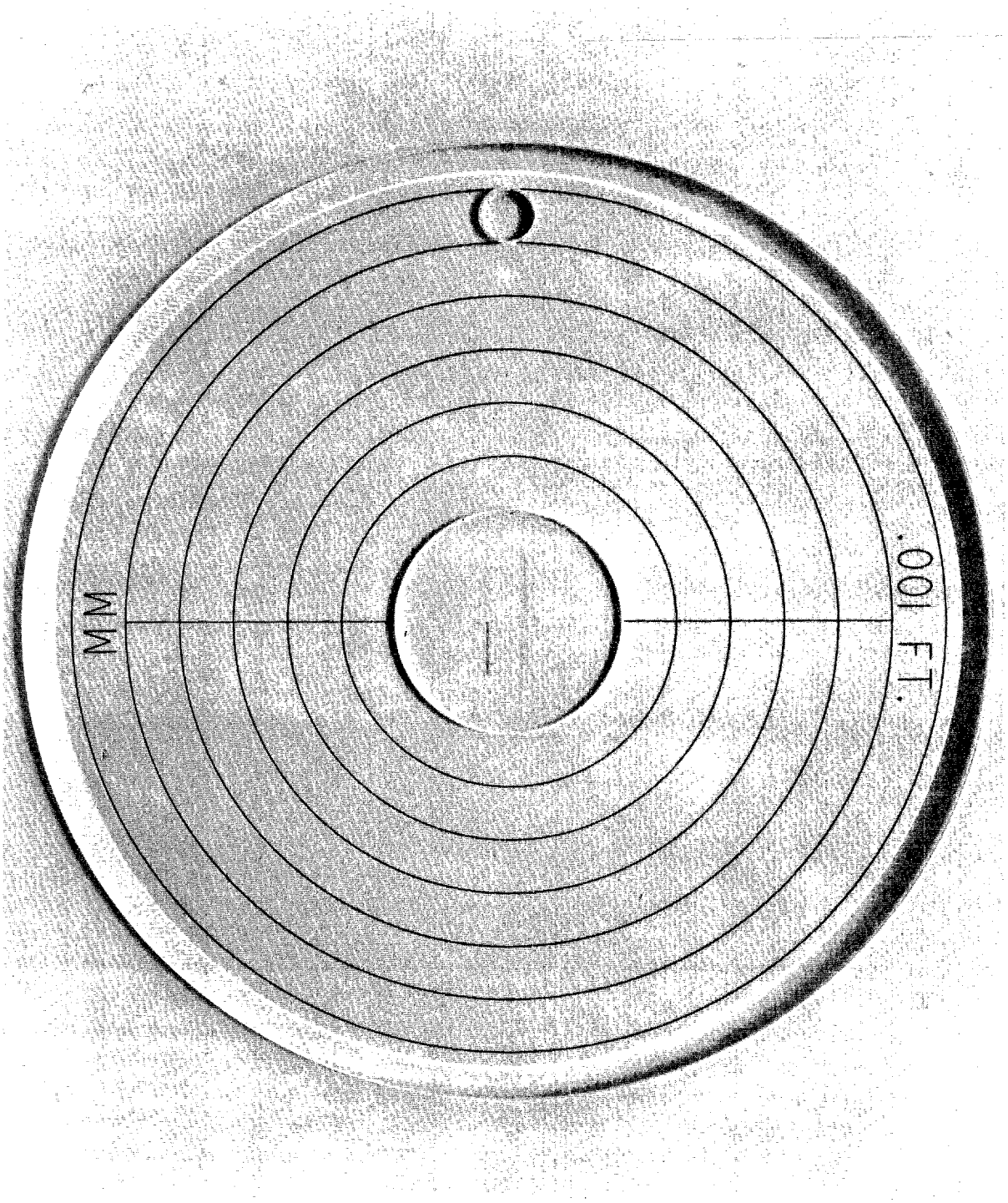

Figure 1. Enlarged Photograph of the P.I. Stage Reticle

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1. INTRODUCTION

Five P.I. stage reticles all essentially identical and manufactured to meet Center development objectives, were tested in May 1973. Test Report TSG/ESD/TEB-22/73 describes the results of the earlier test program.

In brief, the report concluded that the P.I. stage reticles met all design objectives except for one major one. "The graduation marks of the reticles are not in focus when they are used in conjunction with in-focus imagery. This condition, in particular, exists when the reticles are used with higher (60-120X) microscope magnifications."

Recently, four additional P.I. stage reticles were manufactured with two changes in design from the earlier model. This report describes the Test and Evaluation Branch's (TEB/ESD/TSG/NPIC) evaluation of these latest reticles.

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2. DESCRIPTION

The P.I. stage reticle (Figure 1) is a relatively inexpensive mensuration device designed for use by photointerpreters. Basically, it consists of two precisely (positional accuracy ±1 micron) graduated scales, one in metric units (0.02 mm smallest graduation) and the other in English units (0.0001 ft. smallest graduation). The scales are abrasive-resistant chrome deposited on optically polished glass, 21 mm in diameter. To facilitate handling the glass reticle, it is mounted in the center of a transparent 90 mm diameter, 3 mm thick plastic holder. The reticle is positioned on top of photo imagery and under viewing microscopes for making measurements.

Changes Made by Manufacturer

- Protective Coating on Reticle Holder - The reticle holders are made of clear plastic "photoplast" material having a photographic emulsion on one side. Concentric circles are photographically printed on the holder to assist the photointerpreter in centering the reticle. The emulsion of the photoplast part in the first samples of the P.I. stage reticle was protected by a thin coating of silver lacquer which the manufacturer centrifuged on the bottom surface of the holders. This increased wear resistance.

The reticle holders on the latest samples are reported to have been coated with silicon monoxide by a vaporization process. The reason given for the change was that this would provide a more uniform surface flatness.

- Reticle Mounting - Samples tested in May 1973 had reticles recessed to a specified 0.001 inch (+.0005, -.0000) above the bottom surface of the reticle holders.

Of the latest samples submitted for testing, two were reported to be recessed 0.0005 inch and the other two mounted flush (0.0000 inch) with the holder surface.

Prior to TEB testing, the holders were marked for identification. Holders No. 1 and 2 have recessed reticles, whereas Nos. 3 and 4 have flush-mounted reticles.

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3. TEST DETAILS

Reticle Line Quality

Each reticle was examined at 200X magnification for line smoothness and breaks. Three reticles had no defects, but No. 2 had minor breaks in graduation lines.

Reticle Mounting

Test Procedure - A B&L Dynazoom microscope was used at 200X magnification to provide a minimum depth of focus measuring device. Each reticle and holder was placed under the microscope and on top of satin-finish ground glass. The ground glass was brought into focus and the focus position recorded. One end of the measuring scale was then brought into focus and the new focus position (in microns) recorded. This procedure was repeated for each end of the millimeter scale and foot scale. Focus readings were made on four different occasions over a 2-day period. These readings were then averaged.

By this procedure, the position of each reticle in its holder with respect to a flat surface was determined.

Reticle tilt was measured by taking the difference in average focus readings from one end of each scale to the other.

The height of each reticle center above the flat surface was calculated by averaging all "focus difference" measurements made of that reticle. For reporting, this is called the reticle recess. It possibly includes some movement away from the surface because of nonflatness of the reticle holder.

Test Results - Reticle tilt is calculated to be less than 1 minute of angle in most cases and less than 2 minutes in the worst case. The "focus shift" needed from one end of a reticle scale to the other was no greater than 3 microns in most cases and 7 microns at worst. The millimeter scale is 10 mm long; the foot scale is approximately 12 mm.

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Reticle Recess

Reticle No.	Measured Distance		Specified by Manufacturer
	Microns	Inch	
1	25	0.00086	0.0005
2	19	0.00065	0.0005
3	13.2	0.00045	0.0000
4	11.8	0.00041	0.0000

Discussion - For comparison, four of the five reticles tested in May 1973 were recessed approximately 61 microns (0.0021 inch) and the other one 93 microns (0.0032 inch).

The P.I. stage reticle is likely to be used with the B&L Zoom 240 microscope. The theoretical depth of field of this instrument at 120X magnification is 28 microns (0.0011 inch). Therefore, any reticle recessed more than half that amount, 14 microns, is likely to be out of focus.

Reticle Focus Versus Photographic Imagery

Each P.I. stage reticle was positioned over selected targets on aerial film imagery while viewing with a Zoom 240 microscope. Various magnifications up to 120X were used.

At magnifications up to 90X, no shift in focus is necessary to keep both the photographic and reticle images in sharp focus with either reticle sample.

At 120X magnification there is a need for a focus change between photographic imagery and the recessed reticles. This is because the line width of the reticle graduations marks enlarge in their partially out-of-focus condition. This condition was not evident when using the flush-mounted reticle samples.

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4. OPERATIONAL SUITABILITY

One recessed and one flush-mounted reticle sample were operationally used by photointerpreters in IEG for 2 weeks,

STATINTL [redacted]

Verbal reports from these activities indicate that the latest samples of the P.I. stage reticle are well liked. IEG presently lacks the 120X capability for their Zoom 240 microscopes; therefore, tests they made were at 60X magnification. At this magnification both reticle samples were satisfactory. Their preference, however, is for the flush-mounted reticles. This is because they anticipate soon having the 120X Zoom 240 capability with its smaller depth of field.

The two reticles operationally used by IEG were examined for possible wear of the reticle lines and concentric circular lines on their holders. There was no evidence of damage after 2 weeks of photointerpreter use.

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5. CONCLUSIONS

Both the recessed and flush-mounted samples of the P.I. stage reticle submitted for testing are satisfactory for operational use with microscopes up to 90X magnification. At higher magnifications, the flush-mounted samples were superior in performance. This is because of the very limited depth of field at higher magnifications and the need to keep both film imagery and reticle graduations in focus simultaneously.

The new vacuum-deposited silicon monoxide protective coating on the reticle holders is expected to satisfactorily inhibit surface wear because no evidence of damage was detectable after 7 weeks of use.

All of the design objectives for the P.I. stage reticle have been met.

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